

Exploring Gender and Self-confidence in Engineering Students: A Multi-method Approach

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Source: Proceedings of the 2009 American Society for Engineering Education Conference

Despite generally higher academic achievement, female students display lower academic self-confidence than males. Of particular interest to engineering educators is the difference in confidence in mathematical, scientific and problem-solving skills. Using a multi-method approach that utilizes the rich dataset of the Academic Pathways Study, the researchers were able to consider approaches to understanding the ‘confidence gap’ in engineering students.

Implications of Findings

The team’s findings that women and men tend to value their educational and related work and research experiences differently suggest that there is a point of intervention. There are several pedagogical mechanisms to help students to reflect on their experiences and tie them intentionally to the skills and knowledge acquired through engagement in those educational activities, including professional portfolio development, critical reflection exercises, and small group interactive seminars. Creating opportunities for such mechanisms may be one way to address the confidence gap.

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Methods and Background

This paper uses a mixed-methods approach to inquiry known as a “concurrent triangulation” design, where the integration of the results from the various methods occurs during the interpretation phase, enabling researchers to address a broad range of research questions directed toward discerning complex phenomena like student learning and development. The advantage to this approach is that it combines the power of quantitative methods to identify a phenomenon that occurs across a larger sample of students with the power of qualitative methods to provide a robust description of the phenomenon. Survey data were used to investigate population-level differences by gender. Data were derived from the Persistence in Engineering survey (PIE), a component of the Academic Pathways Study (APS). This survey was administered longitudinally to a cohort of 40 students at each of the four CAEE institutions ($n=160$ in total). The first-year students who entered the APS were either in an engineering program or were intending to major in engineering. The sample discussed in this paper consists of the subset of study participants who persisted in engineering until graduation. This sample included 45 females and 62 males, for a total of 107 persisters. It should also be noted that the student participants in the APS were what we consider “traditional” students: those who enter college as very young adults and attend full-time until the completion of their degrees. This paper focuses on three constructs that

measure different aspects of academic self-confidence. Each construct comprises two or more items (questions).

I. Confidence in math and science skills:

- a) math ability
- b) science ability

II. Confidence in open-ended problem-solving skills:

- a) Creative thinking is one of my strengths.
- b) I am skilled in solving problems that can have multiple solutions.
- c) Critical thinking skills.

III. Professional and interpersonal confidence:

- a) Self-confidence (social)
- b) Leadership ability
- c) Public speaking ability
- d) Communications skills
- e) Business ability
- f) Ability to perform in teams

For items IIa and IIb, respondents were asked, “Please indicate how much you disagree or agree with each of the statements” with the options disagree strongly, disagree, agree, agree strongly. For the remaining items, the prompt read, “Rate yourself on each of the following traits as compared to your classmates. We want the most accurate estimate of how you see yourself.” The options for these items were lowest 10%, below average, average, above average, and highest 10%. The Cronbach’s alpha score was calculated for each set of items to confirm intra-construct reliability.

A repeated-measures analysis of variance (ANOVA), using gender and administration (time) as the factors, was then performed with the data. The ANOVA provides information on overall differences between men and women’s responses, effect of administration, and any interaction effect. If the overall ANOVA was statistically significant for either gender or time, it was followed by additional statistical tests (see full paper at the link below for a complete description of the statistical analyses performed for this study).

What We Found

The quantitative data indicates that, over the course of the four years of their engineering education, men have higher confidence than women in their math and science abilities and in their ability to solve open-ended problems. No difference was observed in confidence in professional and interpersonal skills. While the gap in academic self-confidence for male and female students is statistically significant, the confidence for both genders is high and the numerical magnitude of the gap is small. It is true that engineering majors of both genders do have high levels of self-confidence in mathematics (which has been well-studied) relative to other majors. However, the observed gap between the genders does appear to be meaningful; from the interviews, it’s apparent that marked differences exist between male and female engineering majors, as demonstrated by both spontaneous verbalizations about confidence and in the different responses to questions by men and women. For instance, both men and women volunteered “confidence” as being an issue related to gender, and some male respondents who

perceived women as having special advantages over men in engineering speculated that maybe the women they knew actually weren't as good or deserving of rewards as their male peers. Together, the qualitative and quantitative data suggest that there is a clear difference in academic self-confidence between male and female engineering students, even when the study group is restricted to those who could be considered successful, having completed their engineering degree in four years.

It's unlikely that there is a single, specific reason for the existence of this 'confidence gap,' and the suggestions discussed at length in the full paper (see link below) do not exhaust the possibilities for why the gap might exist, although they do suggest possible routes for considering how to address these differences. And the evidence does suggest that this gap results in women engineering students being shortchanged. Data suggest that self-confidence in a particular academic area affects whether a person will attempt or persist in a task, and may be a key to career decisions. While the overall confidence of women in areas such as mathematics may be high relative to women in other majors, they may be disadvantaged compared to their male peers in engineering when it comes to pursuing opportunities such as graduate school and engineering positions. Having lower self-confidence means that women may be more likely to decide that they aren't 'good enough,' and therefore disproportionately decline challenging opportunities. More perniciously, however, this consistent gap may also affect their experiences while in engineering school. For example, in team-based projects, this lower confidence means that women may be less likely to volunteer for the more 'technical' tasks, and this would certainly be consistent with the speculation that women are more likely to take on 'administrative' tasks (note-taking, planning, and the like). If women have less self-confidence than their male colleagues and therefore are less likely to assert themselves to focus on the technical aspects of a group project, this 'confidence gap' may turn into a genuine 'experience gap' over the course of four years. Fortunately, we did not see an experience gap in our respondents. All were high-performing engineering students and most had a myriad of substantive experiences outside the classroom (e.g., internships, summer jobs, research projects, design competitions, service organizations, and so on) that would contribute to their value to even the most discerning employer. Yet, the perceptions of both women and men remained: that women were somehow less well equipped for engineering work than their male counterparts.